

ART. XXVI.—*New or Little-Known Victorian Fossils in
the National Museum.*

PART XII.—ON A TRILOBITE FAUNA OF UPPER CAMBRIAN
AGE (OLENUS SERIES) IN N. E. GIPPSLAND, VICTORIA.

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(With Plates LVIII., LXL.)

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Introduction.

A preliminary note has already been written¹ touching briefly upon this interesting collection of fossils, which were obtained by Mr. E. O. Thiele, B.Sc., F.G.S., from the Dolodrook River in the Mt. Wellington District of N.E. Gippsland. In that note the writer recorded the occurrence of *Agnostus*, together with some, at that time, doubtful portions of opisthoparian trilobites, of which only parts of the cephalæ and the pygidia were preserved. The latter specimens, it was then suggested, might possibly belong to (?) *Cheirurus* and (?) *Proetus*. An exhaustive examination of these fragments, of which there are many, has shown, however, that the two doubtful forms last mentioned really belong to *Crepicephalus* and *Ptychoparia*, both of which are generic types of strong Cambrian affinities. Further than this, the prolific remains of *Agnostus*, of the type of *A. pisiiformis*, practically fix the age of the trilobite limestone as Upper Cambrian.

The pale grey crystalline limestone, found in apparently the same belt as the dark grey trilobite rock, contains brachiopods and a (?) *Girvanella*. The brachiopods are somewhat large for Cambrian forms, and belong to the group *Plectorthis*. This subgenus of *Orthis* has not been found below the Lower Ordovician in the North American region, where it is best known; but in

1 F. Chapman. Proc. Roy. Soc. Vic., vol. xvi. (n.s.), pt. i., 1908, pp. 268, 269.

Great Britain one of its members, *O. (Plectorthis) hicksii*, Davidson, is a characteristic fossil of the Middle Cambrian (Menevian Beds). In China the same type of shell is seen in *O. linarssoni*, Kayser, from the rocks of Ta-ling. This species of brachiopod is found, according to C. D. Walcott, in both the Middle and Upper Cambrian faunas of China.¹

The brachiopod limestone was found at a spot close to Roan Horse Gully, a tributary of the Dolodrook River, whilst the trilobite limestone occurred on the Dolodrook River at the western end of the belt.² Regarding the stratigraphy of the exposures of limestone, Mr. Thiele has remarked as follows³:—"These rocks occur as a number of small lenticular outcrops along a line conforming in general to the strike of the [Upper] Ordovician rocks, and a short distance away from the serpentine belt, on its south-western side." The bed of limestone at Roan Horse Gully is referred to by Mr. E. J. Dunn⁴ as follows:—"It appears to be resting on the serpentine. It may belong to the series of beds exposed at the junction of Thiele's Creek and Dolodrook Creek, where there is another outcrop. A third outcrop occurs a few chains above the junction of Black Soil Gully with Dolodrook Creek, on the west side of the latter creek. These limestone outcrops all appear to be of the same age, and the last-mentioned is said to be traceable at intervals for a mile in a south-west direction." Mr. Dunn further remarks:—"The sedimentary beds now stand at an angle of 80 deg. to 85 deg."

In view of the present discovery of undoubted Cambrian rocks in Victoria, it will be interesting to examine at a later date some further evidence, lately obtained, regarding the Heathcote (Knowsley) trilobite fauna: as well as that of certain fossils obtained near Mansfield doubtfully referred to the Cambrian. Respecting the Knowsley trilobites, Mr. R. Etheridge has already given copious notes⁵ regarding the relationship of *Dinesus* to

1 Proc. U.S. Nat. Mus., vol. xxix., 1906, pp. 4, 5.

2 Consult map in O. E. Thiele's "Notes on the Dolodrook Serpentine Area and the Mt. Wellington Rhyolites, North Gippsland." Proc. Roy. Soc. Vict., vol. xxi. (n.s.), pt. i., 1908, pl. xi., facing p. 268. The trilobite occurrence is there marked L. 1, and the brachiopod limestone L. 4.

3 Loc. supra cit., p. 263. See also Vict. Nat., vol. xxiv., 1907, p. 26, where Mr. Thiele states that the limestone is surrounded by the graptolites slates.

4 Rec. Geol. Surv., vol. iii., pt. 8, 1909, p. 68.

5 Proc. Roy. Soc. Vict., vol. viii. (n.s.), 1896, p. 60.

Dorypyge, a typical Cambrian genus, to which the former seems quite closely allied: and latterly Mr. C. D. Walcott has also remarked¹ on the relationship, stating that *Dinesus* of Eth., jnr. (the pygidium of which is now referred by Prof. J. W. Gregory to *Notasaphus*)² appears to be more nearly related to *Dorypyge*, Dames, than to *Damesella* or *Dorypygella*, Walcott." The genus *Dorypyge* is found throughout the Cambrian, and, in China, also occurs in a bed above the *Agnostus* zone.

With regard to the affinities of the Liau-tung fauna, which shows some points in common with that of the Mt. Wellington limestones, Dames considers it to correspond with the Scandinavian Andrarum Limestone, and to the lowest division of the Potsdam Sandstone in America.³

General Characters of the Limestones.

The trilobite-bearing limestone is dark bluish grey in colour, and partially crystalline. The samples collected by Mr. E. O. Thiele are crowded with the remains of these crustacea, chiefly parts of the cranidia, with an occasional pygidium of the larger forms: whilst the heads and tails of *Agnostus* are found scattered pretty freely over the fractured surfaces of the rock. Several fragments of the thoracic pleurae, presumably of *Ptychoparia* and *Crepicephalus*, can be distinguished, but no connected pieces were obtained. Evidently the membrane connecting the elements of the thoracic region was excessively delicate and easily separated.

In thin sections under the microscope the trilobite limestone is seen to be practically calcitic, having a coarsely crystalline structure. (See Pl. LX., Fig. 25.) The matrix contains innumerable sections of the trilobite carapaces cut in all directions. The latter are usually encrusted on both upper and under surfaces by a thin layer of a black carbonaceous substance of a granular texture, commonly seen in trilobites that are at all well preserved. The thickness of these fragments of trilobite

1 Proc. U.S. Nat. Mus., vol. xxix., 1906, p. 35.

2 Proc. Roy. Soc. Viet., vol. xv. (n.s.), pt. ii, 1903, p. 155, pl. xxvi., figs. 11, 12a, 12b, 13.

3 Dames, in Richthofen's "China," vol. iv., 1883, p. 28. See also H. Woodward, Geol. Mag., 1905, pp. 212, 213.

tests varies from .05 to 1 mm. Numerous fine cracks and fissures traverse the limestone in all directions, and are filled generally with a black granular substance, which in this case may be a basic mineral infilling, such as one of the sulphides. Otherwise the limestone is fairly pure, and no quartz grains were noticed in the sections examined.

The limestone found near Roan Horse Gully, which consists largely of (!) *Girvanella* pellets in a fine-grained matrix, and also contains brachiopoda and joints of crinoids, is much paler than the trilobite limestone, and generally of a light grey colour. (See Pl. LX., Fig. 26.) This rock, also, has a nearly pure calcitic composition; and there is a marked absence of the black carbonaceous and other matter so abundant in the darker limestone. No trilobite fragments were noticed in this rock, but it appears, nevertheless, to be merely a different lithological condition in the same geological stage.

Systematic Description of the Fossils.¹

PLANTAE.

Class ALGAE.

Genus *Girvanella*, Nicholson and Etheridge fil., 1880.

(?) *Girvanella*, sp. (Pl. LX., Fig 23, Pl. LXI., Fig. 26).

Observations.—A hand specimen of grey limestone, rather paler in colour than the trilobite rock, is composed largely of ovoid pellets formed by an enwrapping or encrusting organism like *Girvanella*. One of these pellets measures as much as 15 mm. in length. This rock was mentioned in a previous note published in 1907,² when the limestone was ascribed to the Silurian, partly on account of the prevalence of that form elsewhere in Victoria in beds of similar age; and also because of the *Platystrophia*-like Orthid, accompanying it. The latter fossils are here shown to be distinct from *Platystrophia*

¹ Mr. E. O. Thiele, B.Sc., F.G.S., who collected these specimens, has kindly presented them to the National Museum, Melbourne.

² Vict. Nat., vol. xxiv., p. 34.

biforata, being smaller and not so spiriferoid in shape. The pellets forming this rock were described in the note above referred to as follows:—"These form a large part of some of the limestones, perhaps as much as 40 or 50 per cent., but their intimate structure has been entirely removed by secondary crystallisation, and only traces of the concentric mode of growth can be seen, together with a nucleus of a shell-fragment or crinoid joint."

There is now little doubt that the *Girvanella* and trilobite limestones occur in or near the same stratigraphical horizon, and that the former may be older than was originally thought from the field and palaeontological evidence. Another and similar specimen of *Girvanella* limestone was subsequently obtained by Mr. E. J. Dunn, F.G.S., Director of the Geological Survey, from Roan Horse Gully, Wellington River, and this was reported upon by the writer in 1908.¹ The pellets were there referred to as being from 5 to 6 mm. in length, and crinoid ossicles were seen in the rock in great abundance.

These *Girvanella* limestones are of a good blue-grey colour, and would make a handsome marble for ornamental purposes when polished.

Horizon.—Upper Cambrian. Brachiopod Zone. Roan Horse Gully.

ANIMALIA.

Class CRINOIDEA.

Crinoid stem-joints and ossicles, indet. (Plate LIX., Figs. 16 *a*, *b*, 17 *a*, *b*.)

Description.—Two isolated specimens of stem-joints were obtained from the pale grey limestone by fracture.

A.—A series of eight conjoined infranodals, very low; forming part of a stem circular in section; the axial canal pentagonal or rosette-form; articular facets indistinctly radially striate, and slightly crenulate at the margin. Diameter, 4 mm.; total height, 3.1 mm. (Fig. 16, *a*, *b*.)

¹ Rec. Geol. Surv. Vict., vol. ii., pt. iv., p. 211.

B.—Probably a nodal columnar joint; with a rounded periphery, but inclined to be subpentagonal in outline; axial canal pentagonal; area around perforation depressed on both facets, and having five distinct grooves from axis to margin; surface smooth, tumid between the radial grooves. Diameter, 5.25 mm.; height, 2.6 mm. (Fig. 17 *a, b*.)

Some ossicles (? arm-joints) are found forming the nuclei of the (?) *Girvanella* pellets, but these also are obviously of an indeterminate character.

Observations.—In the Appendix to the chapter on the Crinoidea in Eastman-Zittel's Text-book of Palaeontology,¹ it is stated that "Crinoidal fragments have been detected in the Cambrian, but consist of stem-joints only (*Dendrocrinus*)."

In their "Revision of the Crinoidea" Messrs. Wachsmuth and Springer² give, in the diagnosis of *Dendrocrinus*, "Column pentagonal, or exceptionally round." They record all the species, except one from the Niagara Group, in the Lower Ordovician (Trenton Limestone). The stem of *Dendrocrinus cylindricus*, Billings,³ is of the same general form as our fragmentary specimens indicate, but further comparison is impossible, since the indispensable portion, the crown, is not represented in our series, except by isolated (?) brachials, seen only in sections of the pellets.

Horizon.—Upper Cambrian. Brachiopod Zone. Roan Horse Gully.

Class BRACHIOPODA.

Genus *Lingulella*, Salter, 1861.

(?) *Lingulella*, sp. (Pl. LIX., Fig. 13).

Description and Affinities.—The shell is ventral, and shows the impression of a broad pedicle canal on the denuded umbo. It is ovately pentagonal in outline, with slightly divergent sides, and widely curved anterior margin. There is no dorsal valve to indicate its inaequivalve condition or otherwise, but the width

1 Vol., 1900, p. 177.

2 Proc. Acad. Nat. Sci. Philad., 1879, p. 298.

3 Geol. Surv. Can. Canadian Organic Remains, dec. iv, 1859, p. 44, pl. iii., figs. 8*a, b*.

of the pedicle channel points to *Lingulella* as the probable genus. The surface ornamentation is in parts well preserved, and consists of strong concentric growth lines, crossed by fainter radial lines, after the manner of *Lingulella davisii*, McCoy,¹ of the Lingula Series of Great Britain, which species it also resembles in outline but not in size, being much smaller. A species of *Lingulella*, which Kayser compares with *L. nathorsti* Linarsson, has been figured by the former author² from the Cambrian of the Liao-Tung Peninsula (China). It resembles our specimen in shape, but does not possess any radial striae, such as are clearly seen in our example.

Dimensions.—Length, 3.4 mm.; width, 2.75 mm.

Occurrence.—A single valve adhering to the glabella of *Ptychoparia thielei*.

Horizon.—Upper Cambrian. Agnostus Zone. Dolodrook River.

Genus *Orthis*, Dalman, 1827.

Sub-genus *Plectorthis*, Hall and Clarke, 1892.

Orthis (*Plectorthis*) *platystrophoides*, sp. nov.

(Pl. LIX., Figs. 14, 15).

Description.—Shell of medium size, transversely oval; strongly costate. Hinge-line as long as the entire breadth of the shell; cardinal extremities produced or ending in an acute angle. Dorsal valve semicircular, transversely elongate, moderately and evenly convex, with a faint sinus bearing two costae. Pedicle valve deeper, strongly convex on the median fold, and depressed towards the cardinal angles. Beak prominent and incurved. Area moderately wide, triangular; delthyria large, open; dorsal or brachial valve with a conspicuous cardinal process. Surface of valves with 16-20 strong plicae, with an occasional finer riblet interposed between the primary ones. Faint indications of concentric growth-lines or transverse plicae, with one or two strongly emphasised growth-stages.

¹ McCoy. Brit. Pal. Foss., 1852, p. 252, pl. i.-l., fig. 7.

² In Richthofen's "China," vol. iv., p. 35, pl. iii., fig. 3.

Dimensions.—Width, about 13 mm.; length of dorsal, about 8 mm.; length of ventral valve, about 9 mm.

Note.—One example of a pedicel valve accompanies these specimens, which otherwise are very uniform in size, and which perhaps may be regarded as a senile form of the species. It measures about 17 x 20 mm.; the costae are slightly finer and more numerous, about 30, but are of the same character as those on the smaller and more typical examples. This shell has a broad, shallow sinus.

Observations.—These specimens from near Roan Horse Gully were previously confused with *Platystrophia biforata*, Schlotheim sp., on account of their strongly spiriferoid shape and stout costae with bifid character.¹ Their occurrence, moreover, in a limestone of uncertain age, resembling the Deep Creek limestone, which had already yielded that species, seemed to support that conclusion. Owing to the discovery of an undoubted Upper Cambrian fauna in limestones associated with the brachiopod bearing rock, these fossils have been re-examined and further cleaned of matrix. The group *Plectorthis*, to which these brachiopods belong, is characterised by having biconvex shells and strongly plicate valves. This group is hardly to be distinguished from certain members of the feebler costate forms of *Platystrophia*, excepting in the longer cardinal process, which in the latter is short and stout.

Affinities.—The present species bears relationship to several British forms, notably of Lower Ordovician and Middle and Upper Cambrian facies. In the transversely elongate form of the valves and their extended cardinal angles, comparison may be made with *Orthis alata*, Sowerby.² The character of the costate ornament is allied to that of *O. hicksii* (Salter). Davidson,³ but the ribs are not so numerous as in our species; whilst the latter has a smoother shell-surface. The fold and sinus is not so pronounced as in *Platystrophia biforata*, Schlotheim sp.,⁴ although the large example previously mentioned approaches it

1 F. Chapman. "On Some Fossils from Silurian Limestones, Dolodrook Valley, Mt. Wellington, Victoria." *Vict. Nat.*, vol. xxiv., June, 1907, p. 34.

2 Davidson. *Mon. Brit. Sil. Brach.*, No. 3, 1869, p. 232 pl. xxxiii., figs. 17-21.

3 *Tom. supra cit.*, p. 230, pl. xxxiii., figs. 13-16.

4 See Davidson. *Mon. Brit. Sil. Brach.*, No. 4, 1871, p. 268, pl. xxxviii., figs. 11-25; Hall and Clarke, *Pal. of New York—Pal. Brach.*, pt. i. 1892, p. 200, pl. v.b, figs. 1-10.

in these respects. Another species of the same sub-generic type is *O. (Plectorthis) linarssoni*, Kayser,¹ from the Cambrian of Scandinavia and China. This form, although allied to ours, is not so strongly convex, and differs in the appearance and arrangement of the costae.

The present species differs from the Upper Cambrian orthids of Tasmania indentified by R. Etheridge, junr. as *Orthis lenticularis*, Wahlenberg sp.,² in having a biconvex shell. The latter species appears to belong to the genus *Orthis* sensu stricto, and the brachial valve in that form is nearly flat. Etheridge in his description especially mentions that the Tasmanian specimens are not allied to *O. hicksi*, whereas ours clearly show an affinity with that species.

Class GASTEROPODA.

Genus *Scenella*, Billings, 1872.

Scenella tenuistriata, sp. nov. (Pl. LIX., Figs. 18a, b).

Description.—Shell small, subconical; aperture ovate; apex eccentric, obtuse, slightly incurved towards the longer extremity. In side view boldly convex from apex to margin on shorter side; on longer side concave under the apex, then becoming convex and meeting apertural margin almost vertically. Surface relieved with a few delicate subradial striae inclined towards the longer side, otherwise smooth.

Dimensions.—Length, 2.75 mm.; width, 2.4 mm.; height, 1.6 mm.

Affinities.—Practically all the described species of the above genus are from the Middle Cambrian; but there is an undescribed species from the Upper Cambrian (Potsdam Sandstone) of Wisconsin mentioned by C. D. Walcott³ which may be at least allied with our form, as that author compares it with

1 *Orthis hicksii* (Salter), Dav. aff. Linarsson, 1875, Brach. of the *Paradoxides*-beds of Sweden,—Bihang till Svenska Vet. Akad. Handl. bd. iii., No. 12, pl. iii., figs. 22, 23. *O. linarssoni*, Kayser, 1883, in Richthofen's "China," vol. iv., p. 34, pl. iii., fig. 1.

2 Rec. Aust. Mus., vol. v., No. 2, 1904, p. 101, pl. x., figs. 5-9.

3 Bull. U.S. Geol. Surv., No. 30, p. 127.

(?) *Scenella varians*,¹ a species from the Middle Cambrian of the United States and Canada, resembling our fossil in some particulars. The related genus *Stenotheca* occurs in the Cambrian of South Australia, and is distinguished from the above genus by its stronger, rugose shell and curved beak. The latter feature is not emphasised to any degree in our specimen, and the smoother shell shows it to be distinct from *Stenotheca* in that respect.

Horizon.—Upper Cambrian. Agnostus Zone. Dolodrook River.

Class CRUSTACEA.

Sub-class *Trilobita*.

Genus *Agnostus*, Brongniart, 1822.

***Agnostus australiensis*, sp. nov.**

(Pl. LVIII., Figs. 9, 11. 12).

Description.—Head subquadrate, margin narrow. Glabella conical, narrow, bilobed; anterior lobe small, pointed in front, half as long as the posterior; posterior lobe wider and sub-rectangular; basal lobes small, sub-triangular. Cheeks elevated, surface dull, relieved by very faint radial striae; not so elevated as glabella, and of nearly equal width except in region of anterior glabellar lobe, where they are wider.

Thorax not well preserved in our specimens; portions of lateral and axial elements somewhat crushed, but apparently rather wide.

Tail broad, sub-circular, with a narrow margin produced into short spines at the posterior angles; axis moderately wide, anterior segment narrow, almost bilobed by the intrusion of the middle segment which is anteriorly produced and bearing a strong central tubercle; posterior segment large, elliptical or guttate, being produced behind into a blunt point. Lateral lobes of uniform width, except where confluent behind the pos-

¹ Op. cit., p. 127, pl. xii., figs. 2, 2a.

terior segment. Occasional faint tubercles and striae are seen both on the lateral lobes and axis.

Dimensions.—Head-shield (small specimen); length, 2.5 mm.; width, 2.75 mm. Tail-shield: Length, about 4.5 mm.; width, 5 mm.

Affinities.—This form is closely related to *Agnostus pisiformis*, Linné, sp., and is therefore embraced in the section Longifrontes of Tullberg.¹ In general shape and structure it resembles *A. pisiformis* (typica),² especially in the form of the cephalon; but in the breadth of the pygidium it is most like the variety of that species named *obesus* by Belt.³

Robt. Etheridge in his "Fossils of the British Islands,"⁴ includes *A. pisiformis* under *A. princeps*, Salter, together with Belt's variety *obesus*, and gives the horizons as Lingula Flags and Tremadoc. On the other hand Lake, in his later and more critical work,⁵ states that Salter's *A. princeps* was founded on specimens of three distinct species—viz., *A. trisectus*, Salter, *A. pisiformis*, L. sp., and *A. rudis*, Salter. To revert to Lake's determinations of *A. pisiformis* var. *obesus*, and its horizon, that author gives the latter as Lower Lingula Flags, but adds, "In some cases the horizon is given as Menevian, in others Upper Lingula Flags, but these determinations may be doubted."⁶ It will therefore be seen that the nearest allied form to our species, as occurring in Britain, is typical of the Upper Cambrian or Olenus Fauna.

Another species with which comparison may be made is *Agnostus punctuosus*, Angelin,⁷ a species found in the Paradoxides fauna (Menevian). This form differs, however, in the closely tuberculated surface of the head and tail, and also in the less tumid cheeks and pygidial lobes.

1 See P. Lake. Mon. Brit. Cambrian Trilobites, Pal. Soc., 1906, pp. 2, 3.

2 *Battus pisiformis*, L. sp., Hisinger, 1837, Leth. Succ., p. 19, pl. iv., fig. 5 (figured head downwards). *Agnostus pisiformis*, L. sp., Angelin, 1852, Pal. Scand., p. 7, pl. vi., fig. 7. Lake, Mon. Brit. Camb. Trilobites, 1906, p. 9, pl. i., fig. 12.

3 Belt. Geol. Mag., vol. iv., 1867, p. 295, pl. xii., figs. 4a-d. Lake, loc. cit. p. 9, pl. i., figs. 13, 14.

4 Vol. i., Palaeozoic, 1888, p. 40.

5 Loc. cit., p. 12.

6 Loc. cit., p. 10.

7 Angelin, Pal. Scand., 1852, p. 8, pl. vi., fig. 11. Lake, loc. cit., p. 4, pl. i., figs. 4-6.

Agnostus chinensis, Dames,¹ is another species allied to ours. It was described from the Cambrian beds of the Province of Liao-Tung, China. This species shows the same general characters as ours, but in *A. chinensis* the lateral lobes of the tail-shield are not so wide, thus agreeing more nearly with *Agnostus pisiformis*; and moreover, the pygidial axis is not so bluntly pointed posteriorly.

Horizon.—Upper Cambrian, Agnostus Zone, Dolodrook River.

Genus *Ptychoparia*, Corda, 1847.

***Ptychoparia thielei*, sp. nov.²**

(Pl. LVIII., Figs. 2, 3, 5, 7, and 10).

Description.—Head-shield large, comparatively broad in front. Glabella large and tumid, elongate and tapering somewhat towards the front; more than two-thirds the entire length of head; surface finely tuberculate, marked by about four pairs of lateral furrows, almost or quite continuous. Palpebral lobes sub-lunate, prominent; eye-lobes very narrow, not conspicuous. Facial sutures strongly curved at the eye-margin, turning at a sharp angle anteriorly, directed forward and outward, and then gently inward to the anterior margin, which it meets a little nearer the central line than the eye; from the posterior end of each eye the suture curves gently outwards, then extends horizontally, and finally is directed obliquely to meet the lower border of the strong genal spine. The cephalic border is finely wrinkled and tuberculate; whilst the prominent areas of the free cheeks are radiately wrinkled.

Thoracic segments fragmentary; none in position.

Pygidium semicircular, rounded posteriorly; moderately large, with about eight distinct segments. Surface finely tuberculate. Axial lobe elevated, rounded, extending to the posterior border; width at the anterior region equalling about one-third of the lateral lobes; the latter depressed or only slightly convex.

Dimensions.—Width of cephalic shield to bases of spines (approximate), 59 mm.; length through the central axis, 15.5

1 In Richtofen's "China," vol. iv., 1883, p. 27, pl. ii., figs. 18, 19.

2 Named in honour of its discoverer, Mr. E. O. Thiele, B.Sc., F.G.S.

mm. Length of pygidium (Fig. 10), 9 mm.; width, about 15 mm.; length of axial lobe, 8 mm.; anterior width of ditto, 3.75 mm.; width of margin, about 1 mm.

Observations.—The material in the present series of limestone specimens shows only the cephalon and pygidia preserved, the thoracic portions being disarticulated and so damaged as to make it difficult to decipher more than a few isolated pleurae. There is very little doubt about the pygidia here regarded as belonging to the cephalon of *Ptychoparia*, as they show similar superficial tuberculations, and by their numerous segments they show further relationship to that genus. Notwithstanding the variability of form in species of this and other related trilobite genera, it seems advisable to regard the specimens represented by Figs. 1, 4 and 6 as parts of a distinct form, next described.

Affinities.—The large cephalon, with its conico-cylindrical glabella and wrinkled border, shows the relationship of the above species to *Ptychoparia*. It is a member of the Olenidae on account of its large free cheeks, which cut the anterior margin but do not meet, but is naturally separated from *Olenus* on account of its tapering glabella and its large pygidium; and from *Olenellus* by the absence of a pygidial spine. The glabella of *Ptychoparia thielei* closely resembles that of "*Olenellus* sp." of Mr. Etheridge, junr.; a species from the Cambrian of South Australia.¹ Of that form only an imperfect cranidium was found. Etheridge, in his description of this fossil, mentions the genus *Ptychoparia*, but thinks that the evidence indicates *Olenellus* rather than that genus. With the additional evidence of the associated pygidia in our species the comparison may be worth further consideration.

The cranidium of *Olenellus* (!) *forresti* (Eth., junr., MS.), from the Cambrian of Western Australia, described and figured by Dr. H. Woodward,² resembles in some respects the above species, but the glabella is more decidedly conical, and proportionally narrower. Fig. 2a on Dr. Woodward's plate, referred to as a telson, resembles some fragments with genal

1 Trans. Roy. Soc. S. Australia, vol. xxix., 1905, p. 247, pl. xxv., fig. 1.

2 H. Woodward, in Foord's "Notes on the Palaeontology of Western Australia." Geol. Mag., March, 1890, p. 99, pl. iv., figs. 2, 2a, b.

spines, on our limestone samples. This is mentioned merely as a point worth consideration.

Horizon.—Upper Cambrian. Agnostus Zone. Dolodrook River.

***Ptychoparia minima*, sp. nov.**

(Pl. LVIII., Figs. 1 and (?) 6 ; Pl. LIX., Fig. 22).

Note.—The subjoined description is founded principally on a cephalon without the free cheeks ; but a pygidium occurring in the same limestone is also tentatively referred to the present species.

Description.—Glabella subcylindrical, comparatively long, tapering very slightly anteriorly ; upper surface finely pustulate, with three distinct lateral furrows, the two posterior broad, shallow, and with a strong backward curve ; neck-furrow deeply impressed, the neck-ring showing traces of a slight ridge bearing three small blunt spines directed posteriorly. Anterior border of glabella nearly semicircular, but somewhat truncated in front, broad and depressed. Palpebral lobes large, prominent, elliptical ; eyes narrow, sublunate and strongly curved.

Pygidium (provisionally referred to this species), comparatively large, with about six well-defined segments. Axial lobe prominent, rounded, rapidly tapering to a point at the posterior border ; narrower than in *P. thielei* ; lateral lobes moderately wide, slightly rounded, and depressed in relation to the axial lobes ; sutures neatly and clearly marked. Margin broader than in *P. thielei*, and with conspicuous striae parallel with the border.

Dimensions.—Length of glabella from base of neck-ring to anterior border, 6.5 mm. ; greatest width of glabella, 3.25 mm. Length of palpebral lobes about 2 mm. ; greatest width of neck-ring, 1 mm.

Pygidium, provisionally referred to this form, length, 7.5 mm. ; greatest width, 11 mm. ; greatest width of axial lobe, 2.2 mm. ; width of border, 1.25 mm.

Observations.—The cranium upon which the above specific description is based is of the same general type as that of the

preceding *P. thielei*. The glabella, however, is shorter, with only three lateral furrows: whilst the palpebral lobes are also shorter and rounder. The form of the glabella and the well developed palpebral and visula areas show its alliance with *Ptychoparia*. Two specimens occur in the present series. The characters of the pygidium, if it be referable to this species, are distinct from that of *P. thielei*, for the axis is slender and the border is definitely striated. This latter feature is also well seen in pygidia of the allied genera *Anomocare* and *Bathyriscus*.

Affinities.—The deep and depressed border of the glabella, and the spinous processes of the neck-ring in *P. minima* may, with advantage, be compared with *Ptychoparia trilineata*, Emmons sp.¹ The latter species occurs in the Middle Cambrian of North America, but generally similar forms range throughout the system. Another interesting trilobite, showing certain characters in common with our species, is the *Conocephalites subquadratus* of Dames,² from the Upper Cambrian of Ta-ling (Liau-tung), China.

Horizon.—Upper Cambrian. Agnostus Zone. Dolodrook River.

Genus *Crepicephalus*, Owen, 1852.

***Crepicephalus etheridgei*, sp. nov.³**

(Pl. LVIII., Fig. 8, (?) Fig. 4; Pl. LIX., Figs. 20, 21) (?).

Description.—Cranidium small, semicircular, inflated. Glabella subspherical or elongately globose, highest along the median longitudinal line; surface faintly marked with three pairs of furrows which curve forwards and outwards from either side of the middle line: frontal border depressed, sulcated and with an almost straight or slightly curved margin: neck-

¹ *Atops trilineatus*, Emmons. "Taconic System," 1844, p. 20. fig. 1; pl. ii., fig. 3. *Ptychoparia trilineata*, C. D. Wallcott, "Second Contribution to the Studies on the Cambrian Faunas of N. America." Bull. U. S. Geol. Surv., No. 30, 1880, p. 203, pl. xxvii., figs. 1, 1a-c.

² In Richthofen's "China," vol. iv., p. 12, pl. i., figs. 9, 11.

³ Named in honour of Mr. R. Etheridge, Curator of the Australian Museum who has contributed so much to our knowledge of Australian Cambrian faunas.

ring narrow, neck-furrow deeply impressed. Fixed cheeks moderately broad, subtriangular, and deeply incised at junction with the glabella; outer margin gently sloping outward posteriorly, and with a semilunar depression on the ocular margin. Surface finely tuberculate.

Pygidium broad, subquadrate, rather depressed; with the posterior border slightly produced and rounded. Axial lobe broad, and rounded on the upper surface, excepting at the terminal which has the upper surface slightly cupped; axis more than three-fourths the length of the pygidium, thus differing from that in *Dikelocephalus*, divided into five segments, all of which, except the posterior, are narrow; axial sutures wide, moderately impressed, and widely curved to almost straight; furrows of the lateral lobes at first gently sloping posteriorly, and then curving sharply backwards. Margin with a doublure, and remnants of two (?) long, divergent spines, directed backwards and outwards.

Dimensions.—

Cranidium — Length from base of neck ring to anterior border, 4.5 mm. Approximate width of cranidium, 8.5 mm. Length of glabella, 3.5 mm.

Pygidium. — Greatest width, 12 mm. Approximate length of present specimen, measured over the middle vertical line, 8 mm. Greatest width of axial lobe, 3.5 mm.

A free cheek (Pl. LVIII., Fig. 4) is also provisionally referred to this species. It is wide, more subtrigonal in shape than those of *Ptychoparia* here previously described, finely tuberculate and radiately wrinkled; anterior margin nearly straight for half the distance to the genal angle, then roundly curved to meet the long, slender, outwardly curved genal spine; external border of free cheek with a narrow rounded margin as far as the genal angle, where it merges into the genal spine.

The dimensions of this free cheek are as follows:—Anterior extremity to genal angle, 5.5 mm.; length of spine, 4.75 mm.; greatest width of free cheek, about 3 mm.

Observations.—Fragmentary examples of what are here regarded as the cranidia of *Crepicephalus etheridgei* (typified by the pygidium) are not uncommon in the Dolodrook Limestone. They show the same superficial characters of a finely

tuberculate surface, as the *Crepicephalus* pygidium; and the darker-coloured fragments, as compared with those of *Ptychoparia*, exactly correspond.

Affinities.—At first sight the cranidia provisionally referred to the above genus and species, might be mistaken for a form like *Sphaerophthalmus alatus*, Boeck sp.¹ (= *Olenus humilis*, Phillips): but there is no deeply marked basal furrow on the glabella corresponding to forms of that genus. R. P. Whitfield has described and figured the cranidium of a species of *Crepicephalus*² which shows all the fundamental characters of the form here dealt with. He also gives a profile view of the same form, and its resemblance to ours is even more striking than the superficial view. The glabella of our trilobite is more decidedly globose than in Whitfield's species, which, although highly convex, is broadly conical; but in both forms the anterior border and the deep neck furrow are similar in character. The fixed cheeks, moreover, are larger in our species. *Crepicephalus onustus*, Whitfield, occurs in the Potsdam Sandstone (Upper Cambrian) of Wisconsin, U.S.A.

The pygidium here regarded as the holotype of the above species shows a remarkable resemblance to that figured as *Crepicephalus liliana*, Walcott, from the Middle Cambrian of Nevada, U.S.A.³ That species is of slender proportions, and the tail spines are less divergent than is indicated in our specimen. The two forms agree in the rounded shape and almost even width of the axial lobe, and in having a deep incision between the last and penultimate suture-line of the anterior region.

This genus occurs throughout the Upper Cambrian in North America. The genotype, according to C. D. Walcott⁴ is *Crepicephalus iowensis*, Owen sp.⁵ It is a characteristic fossil of

1 *Trilobites alatus*, Boeck, 1838, *Gaea Norvegica*, I., p. 143, Pl. (Sph.) *humilis*, Phillips 1848, *Mem. Geol. Surv. Gt. Brit.*, vol. ii., pt. 1, p. 55, woodcuts figs. 4, 5, 6.

2 *C. onustus*, Whitfield. *Geol. of Wisconsin Survey of 1873-9*, vol. iv., 1882, p. 182, pl. i., figs. 22, 23.

3 "Second Contr. to the Studies on the Cambrian Faunas of N. America." *Bull. U.S. Geol. Surv.*, No. 30, p. 207, pl. xxviii., figs. 3, 9a-c.

4 *Op. supra cit.*, p. 206.

5 *Dikelocephalus* (?) *iowensis*, Owen. *Geol. Rep. of Wisconsin, Iowa and Minnesota*, 1852, p. 575, pl. i., fig. 4. *Ptychoparia* (*Crepicephalus*) *iowensis*, Owen sp., C. D. Walcott, *Bull. U.S. Geol. Surv.*, 1884, No. 10, p. 36, pl. vi., fig. 2, 2a.

the Potsdam Sandstone of the Upper Mississippi, U.S.A. *C. iowensis*, it may be remarked, shows similar features to the Australian species; chiefly differing in the broad, flattened bases of the tail spines. The remnants of the latter seen in our example indicate a more slender type of appendage. In all but the pygidial spines *Crepicephalus* agrees with *Ptychoparia*, so that the free cheek above referred to, whilst presenting some of the features of *Ptychoparia*, may reasonably be supposed to belong to the present species.

Horizon.—Upper Cambrian. Agnostus Zone. Dolodrook River.

EXPLANATION OF PLATES LXIII.—LXI.

PLATE LVIII.

- Fig. 1.—*Ptychoparia minima*, sp. nov. Portion of cephalon, without free cheeks. Holotype.
- Fig. 2.—*Ptychoparia thielei*, sp. nov. Free cheek and spine. Paratype.
- Fig. 3.—*Ptychoparia thielei*, sp. nov. Portion of cephalon without free cheeks. Paratype.
- Fig. 4.—(?) *Crepicephalus etheridgei*, sp. nov. A free cheek with spine.
- Fig. 5.—*Ptychoparia thielei*, sp. nov. Free cheek of a large example. Cotype.
- Fig. 6.—(?) *Ptychoparia minima*, sp. nov. Pygidium.
- Fig. 7.—*Ptychoparia thielei*, sp. nov. Part of cephalon without free cheeks. Cotype. (On the left side of the glabella and next the palpebral lobe is a (?) *Linguella*).
- Fig. 8.—*Crepicephalus etheridgei*, sp. nov. Pygidium. Holotype.
- Fig. 9.—*Agnostus australiensis*, sp. nov. Pygidium, and fragment of thoracic region (crushed). Cotype.
- Fig. 10.—*Ptychoparia thielei*, sp. nov. Pygidium. Cotype.
- Fig. 11.—*Agnostus australiensis*, sp. nov. Pygidium. Paratype.
- Fig. 12.—*Agnostus australiensis*, sp. nov. Head of small specimen. Cotype.

All figures on the plate magnified twice.

PLATE LIX.

- Fig. 13.—(?) *Lingulella*, sp. A fragmentary valve adhering to the glabella of *Ptychoparia thielei*. $\times 6$.
- Fig. 14.—Pedicle valve of *Orthis* (*Plectorthis*) *platystrophioides*, sp. nov. $\times 3$.
- Fig. 15.—Brachial valve of *Orthis* (*Plectorthis*) *platystrophioides*, sp. nov. $\times 3$.
- Fig. 16.—Crinoid columnars, indet.: *a*, articular face: *b*, side view. $\times 3$.
- Fig. 17.—Crinoid columnar, indet. Probably a nodal joint: *a*, articular face; *b*, edge view. $\times 3$.
- Fig. 18.—*Scenella tenuistriata*, sp. nov.; *a*, apical aspect; *b*, side view. $\times 6$.
- Fig. 19.—Restoration of the cephalon of *Ptychoparia thielei*, sp. nov. $\times 2$.
- Fig. 20.—(?) *Crepicephalus etheridgei*, sp. nov. Portion of a cranidium, showing the rounded form of the glabella. $\times 2$.
- Fig. 21.—(?) *C. etheridgei*, sp. nov. A cranidium, with tuberculate surface. $\times 2$.
- Fig. 22.—*Ptychoparia minima*, sp. nov. Neck ring, showing the spinose character of the median ridge. $\times 6$.

PLATE LX.

- Fig. 23.—Photomicrograph of a section of the trilobite limestone (Dolodrook River). $\times 14$.
- Fig. 24.—Four examples of *Orthis* (*Plectorthis*) *platystrophioides*, sp. nov. The upper specimen is a brachial valve; the lower, pedicle valves. Roan Horse Gully. About natural size.

PLATE LXI.

- Fig. 25.—A section through one of the (?) *Girvanella* pellets, showing nucleus formed by a crinoid ossicle. Roan Horse Gully. $\times 7$.
- Fig. 26.—Photograph of surface of nodular or (?) *Girvanella* limestone. Roan Horse Gully. About natural size.

CORRIGENDA AND ADDENDUM.

For paper, "A Study of the Batesford Limestone," in this
Journal, Vol. XXII. (N.S.), Pt. II., 1909.

P. 263, line 16 from top, for "N.E." read "N.W."

P. 297, line 8 from top, for "Leptocyclines" read "Lepido-
cyclines."

P. 310, line 12 from top, for "onomata" read "onamata."

P. 510, footnote 3, for "Vol. XXX." read "Vol. XIII."

P. 305, between lines 18 and 19, insert "Echinoneus dennanti,
T. S. Hall."
